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Intraocular Lens Power Calculations in Eyes with Prior Corneal Refractive Surgery

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Accurate intraocular lens (IOL) power calculation is crucial to meet the high expectations of patients undergoing cataract surgery. With current technological advances, IOL power calculation in normal eyes is relatively straightforward. However, it is problematic in eyes that have undergone corneal refractive surgery. There are two major causes of error in IOL calculations in these eyes: 1) inaccurate corneal power measurements obtained from standard keratometers or computerized videokeratography (CVK), and 2) incorrect estimation of effective lens position (ELP) calculated by most 3rd or 4th generation IOL power calculation formulas.

In eyes with prior laser-assisted in situ keratomileusis (LASIK) or photorefractive keratectomy (PRK), several methods have been proposed to improve the accuracy of IOL power calculation in these eyes. These methods can be divided into 3 categories depending on the requirement for preoperative data:

1. Methods requiring historical data: These methods require the preoperative K readings and manifest refraction (MR) and the surgically induced change in MR (ΔMR). The concern with this category is their dependence on the accuracy of preoperative data. There is a one-to-one diopter error if any of the historical data are incorrect. Therefore, care should be taken to obtain accurate historical data, including measurement of the post-LASIK/PRK stable refraction before the cataract has begun to develop.
2. Methods using historical refraction data and current corneal power measurements: With these methods, corneal power measurements or IOL powers are modified based on the amount of refractive change induced by the LASIK surgery (ΔMR). The advantages of methods in this category are that they use corneal data obtained at the time the patient presents for cataract surgery and, by multiplying the change in manifest refraction by some fraction, typically less than 0.3, they avoid the one-for-one error involved in the approaches that rely entirely on historical data.
3. Methods using no prior data: These methods are obviously essential, as one often encounters patients for whom no prior data are available. The advantage of these methods is that they require no historical data and have a low variance when used with either the Holladay 2 formula or a modern 3rd generation 2-variable formula combined with the "double K method" proposed by Aramberri [1] and the correction nomograms published by Koch and Wang [2].

In eyes with prior radial keratotomy (RK), unlike post-LASIK/PRK eyes, posterior corneal curvature also changes, presumably more closely preserving the ratio between the anterior and posterior corneal surface. Therefore an average corneal power over the central 2-3 mm provided by any topographers can be used for post-RK eyes. Compared to post-LASIK/PRK eyes, accuracy in post-RK eyes is relatively poor. This may be in part due to greater variability in anterior and posterior corneal curvature changes that deviate from those estimated by using the standardized refractive index [3]. In addition, it has been reported that 20 to 50% of RK eyes have a gradual hyperopic shift [4].

It is time consuming to perform calculations with various methods. In collaboration with Dr. Warren Hill and Douglas D. Koch, we developed the web-based IOL power calculator (www.ascrs.org).

This calculator has three modules: 1) prior myopic LASIK/PRK, 2) prior hyperopic LASIK/PRK, and 3) prior RK. Using this calculator, our study of 72 post-LASIK/PRK eyes that had cataract surgery found that, compared to methods requiring pre-LASIK/PRK Ks and ΔMR, methods using ΔMR or using no prior data had smaller IOL prediction errors, smaller variances, and greater percentage of eyes within 0.5 and 1.0 D of refractive prediction errors [5]. Another excellent resource is a comprehensive spreadsheet developed by Kenneth Hoffer and Giacomo Savini (http://www.eyelab.com/) [4].

Although the methodology for calculating IOL power in eyes with prior corneal refractive surgery has improved dramatically in recent years, we still see surprises, especially in eyes with prior RK. To meet the high expectations of patients following corneal refractive surgery, further studies and advances are needed in all areas, including methods of measuring corneal power and predicting effective lens position. Intra-operative measurement of aphakic eye using the Optiwave Refractive Analysis system (WaveTec Vision) shows great promise. However, estimation of effective lens position is still an issue. The "Holy Grail" in this field may be an adjustable IOL, which could facilitate correction of residual spherical and astigmatic refractive errors and residual higher order aberrations. Ideally, such an IOL could be modified multiple times to adapt to the patient's changing visual needs and to compensate for aging changes of the cornea.

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